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VARIATION OF EARLY MAIZE COBS WITH ACTUAL MORPHOLOGICAL CHARACTERS

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Abstract
Being in full swing, studies on the variability of morphological characters, along with biochemical and molecular features, are considered very useful for the improvement of new maize hybrids. Rich genetic dowry and maize crop conditions lead to the characteristic expression of plant morphology. In the case of maize, the hybrid Surterra, some new directions have been found, which has recently been improved, with new morphological characters tendencies. Thus, the cobs had an average length of 17 cm, a thickness of 4 cm and weighed 159 g. The number of grains on the cob was 451, weighed 127 g, and the one thousand grains was 280 g. The cobs had 14 rows of grains, 32 grains/row, and the grain/cob percent was 81%. The grains of this hybrid were 10 mm long, 9 mm wide and 4.6 mm thick. Between the analyzed characters of the cob were mostly positive correlations. Grain percent/cob correlated negatively with most characters, while grain thickness correlated insignificantly with other attributes. The new, early-grading hybrid (FAO 250 group), cultivated, has shown a good adaptability to a new and performing agriculture.

Keywords: cobs, grains, maize, variability

1.INTRODUCTION

Having a long history, maize (*Zea mays* L.) is one of the most important crops (Tokatlidis & Koutroubas, 2004). As the surface occupies the first place, followed in the order of rice, wheat and barley. The content of the beans in nutrients is diverse and specific (Winkel-Shirley, 2001), having a particular importance in animal feed, in industry, and in the human diet (floor for polenta). In the course of time, the plant has evolved in different characters (Fasoula & Fasoula, 2002; Doebley, 2004; Haș et al., 2010). So today, maize is still considered an important model of organism for future genetics and biology (Duvick & Cassmen, 2009; Haș et al., 2011). The origin of the plant is lost in time (Wilkes, 2004; Roney, 2009), so the beginning was a rustic species that produced small cobs with a single grain of 25 mm long. This cultivated plant intercalated with *Zea mays mexicana*, or *teosinte*, has evolved, and in time it has been possible to obtain a few cobs with small dimensions (centimeters) on a single plant. Since that time, there are now three *Zea* species, namely: *Zea mays*- ordinary maize, *Zea diploperennis*- the perennial form and *Zea mays mexicana*- the annual form. Maize is expressed in the world by *maize*- originary from *mahiz* (spanish), and by *corn* which in some parts of the world means cereal culture, expression in culinary context. In other parts, corn have been developed from *indian corn= maize*, that means a *flint corn* multi-colored, used for decorations (cobs with grains in different colors, woven and hanging sheets). The diploid plant contains 2n = 2x (2x10) = 20 chromosomes, fixes carbon to type C4, and has a higher efficiency in water recovery (Widdcombe & Thelen, 2002; Tolleaar et al., 2004; Troyer, 2006). As a

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unisexedmonoic species, maize has female flowers grouped in a spice- like inflorescence (Sarca et al., 1990; Schnable et al., 2009) with a spadix spindle. Maize spikelet has a long stigma in grabbing pollen grains, an ovary from which specific grains, glumes and palaea grow at the base (Ştefan, 2004). The maturecob have lengths of 3-50 cm and a diameter of 1.5-6 cm, being cylindrical, cylindrical-conical or fusiform. Their weight is between 50 and 500 g, 8-20 rows of grains are formed on one cob/ear each. Grain is a caryopsis with very great variability in shape, size and color (Osorno & Carena, 2008). Maize grains of 2.5-22 mm have in length, 3-18 mm in width and 2.7-8 mm in thickness. The mass of a thousand grains is between 30 g and 1200 g. The *Surterra* hybrid studied has medium-sized cobs with spadix of white color and reddish yellowish grains. The hybrid belongs to the shape of *Zea mays indurata* (flint corn). The research carried out to observe the variation of maize cob related characters included: i)total length, diameter in central portion, absolute weight, total number of grains, number of rows, grain/cob weight, thousand grain weight-TGW, grains percentage/cob, number of grains, the length, width and thickness of the grains.

2. MATERIALS AND METHODS

Variants have been cultivated in recent years with the early Surterra hybrid (Osorno & Carena, 2008). The experience was set up according to the block method, with variants of 25 m^2 in 4 replicates (rehearsals). The technology used was the one recommended by the resort (Furnham, 2001; Tokatlidis et al., 2005). At the full maturity, randomly, 25 cobs of each rehearsal (totaling 100) were cut and brought into the laboratory. The 100 cobs were measured and determined total length, thickness in the central area, weight, total number of grains, number of rows, total grains weight, thousand grain mass, grains percentage/cob, number of grains per row, grain length, grains width and grain thickness.

The morphological characters obtained were analyzed by the histograms (frequency polygon,%) method. In their expression were used the class ranges established according to the specific value range obtained. The study highlighted several aspects, namely: i)themodal values (with the highest frequencies), ii)the limits of the variability ranges of the studied characters, and iii)the specificity of each character of the maize ecotype in the analyzed area. Between the analyzed characters correlations were established, with the help of which their tendencies within the studied eco-type were observed. The Excel program was used to express the values. The significance of correlation coefficients was obtained by comparing with r_{max} values (Erna Weber, 1961) for the 5%, 1% and 0.1% levels of transgression probabilities.

In the statistical calculation of all the obtained values variance analysis (Anova test) was used on the variation rows. Statistical parameters were calculated using the following formulas:

$\bar{a} = \Sigma x/n$, where $\bar{a}$ = media of determinations, and x = values,

S^2 (variance) = $1.(n-1)^{-1}.[\Sigma x^2-(\Sigma x)^2.n^{-1}]$,

S (standard error) = $\sqrt{s^2}$ and

S % (variation coefficient) = $s.\bar{a}^{-1}.100$.

RESULTS OBTAINED

Variability of maize cobs. The appearance and dimensions of the maize hybrid are characteristic (Haş et al., 2008; Haş et al., 2010). Thus, its length was between 10.8 and 19.8 cm. They dominated the lengths of 16-17 cm (21%), followed by 17-18 cm (17%) (figure 1). Cobs of 14-15 cm and 15-16 cm had frequencies of 11-12%. The longest cobs (19-20 cm) constituted 8% of the total. In the case of the length of this hybrid cobs there is a fluctuation of variability, possibly due to the specific conditions of crop/culture (figure 2).

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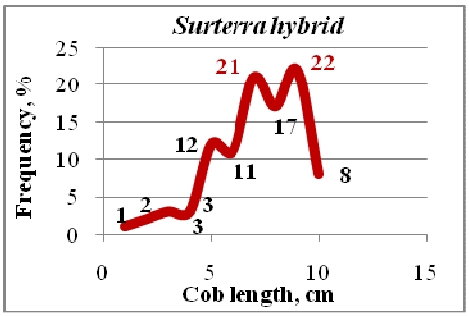

Figure 1. Frequencies of the cob length, cm:
10.1-11, 11.1-12, 12.1-13, 13.1-14, 14.1-15, 15.1-16, 16.1-17, 17.1-18, 18.1-19, 19.1-20

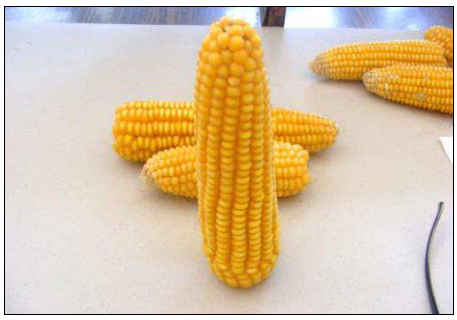

Figure 2. The cob aspect, Surterra hybrid

The width (thickness) of the cob in the central portion ranged between 3.5 and 4.8 cm. Dominated cobs have 4.3-4.4 cm (29%) thickness, followed by the size of 3.9-4.0 cm and 4.1-4.2 cm with 22% participation each. Thicker and taller cobs together amounted to 5% (figure 3). The weight of the cob ranged between 72 g and 243 g. Were dominated cobs weighing between 170 g and 190 g (17%) and between 130 g and 150 g (16%). Smaller weights, 70-90 g were 5%, and those with 230-250 g 3% of the total (figure 4).

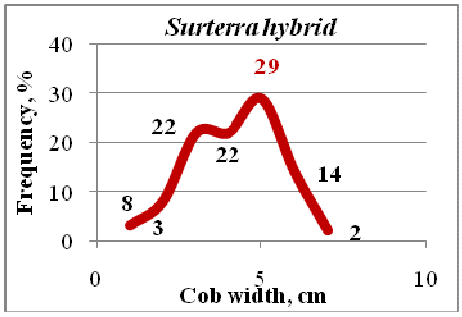

Figure 3. Frequencies of cob width, cm:
3.5-3.6, 3.7-3.8, 3.9-4.0, 4.1-4.2, 4.3-4.4, 4.5-4.6, 4.7-4.8

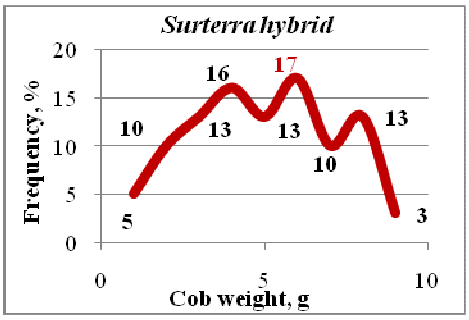

Figure 4. Frequencies of cob weight, g:
70.1-90, 90.1-110, 110.1-130, 130.1-150, 150.1-170 170.1-190, 190.1-210, 210.1-230, 230.1-250

The number of grains on one cob ranged from 258 to 570. They dominated the cobs with a number of 450-489 (25%), followed by the number of grains ranging from 490 to 529 (22%). The extremes of the number of grains on one cob together consisted of 5% (figure 5). The weight of the grains on one cob ranged between 61.7 g and 183.6 g. The modal value was 120-140 g/cob (22%), followed by beans weighing 140-160 g (21%) and those with 100-120 g (19%). Cobs with smaller grains were 7% and those with the heaviest grains 3% (figure 6).

The absolute grain weight (TGW) had a fairly large variability, ranging from 193.1 g to 388.8 g. The modal value was 265-290 g (22%), followed by 240-265 g (21%). Lower values (190-215 g) were 5% and those over 340 g 8% (figure 7). Grains with such weights showed specificity of this hybrid (figure 8).

Variability of maize grains. The research found that both the cobs and the grains they form have a very high morphological diversity. From the data presented in the case of the Surterra hybrid, the cobs had different and varied specific features. And in the case of grain morphology, some peculiarities were found. A different number of rows of grains are formed on a cob. The study showed that the cob had between 12 and 18 rows of grains. Fourteen rows (56%) were dominant,

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followed by 16 rows (16%), while the extremes had 12 rows (15%) and 18 rows (3%) respectively (figure 9). Each row-grain was between 17.9 and 38.6 grains number. The ranks dominated with 32-35 grains/row, followed by 35-38 grains/row (23%). Cobs with fewer grains per row (17-20) represented 2%, while rows with 38-41 grains accounted for 3% of the total (figure 10).

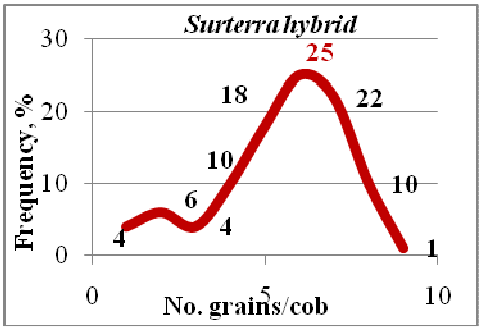

Figure 5. Frequencies of no. grains/cob
250-289, 290-329, 330-369, 370-409,410-449, 450-489, 490-529, 530-569, >570

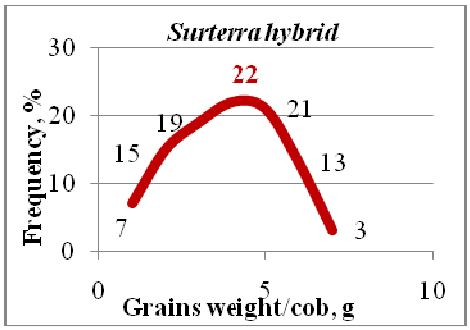

Figure 6. Frequencies of grains weight/cob
60.1-80, 80.1-100, 100.1-120, 120.1-140, 140.1-160, 160.1-180, 180.1-200

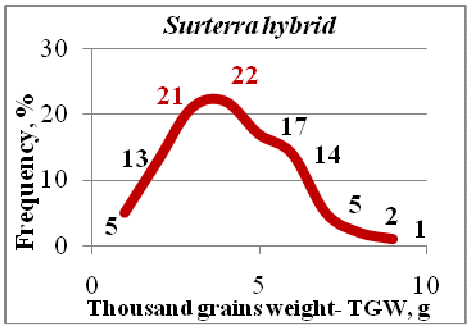

Figure 7. Frequency of TGW evolution, g:
190.1-215, 215.1-240, 240.1-265, 265.1-290, 290.1-315, 315.1-340, 340.1-365, 365.1-390, >390

Figure 8. The grains aspect of Surterra hybrid

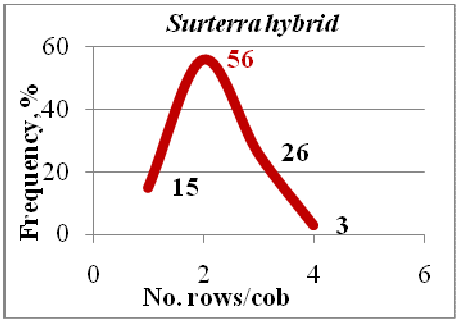

Figure 9. Frequencies of rows number/cob:
12, 14, 16, 18

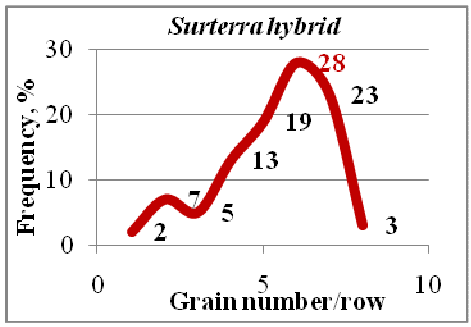

Figure 10. Frequencies of grain number/row:
17.1-20, 20.1-23, 23.1-26, 26.1-29, 29.1-32, 32.1-35, 35.1-38, 38.1-41

The degree of filling of grain cobs is characterized by a specific proportion (%). The Surterra hybrid has proven a good and very good degree of grain percent from a cob. The data showed that the percent oscillated between 73.7 and 87.9%. The modal value was 80-82% output (31%), followed by 78-80% (21%). The analyzed character showed quite large limits (figure 11). The lowest ones constituted 1% of the total. In terms of grains characters, determinations were made for length,

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width and thickness. The first character of the grain, length ranged from 7.5 mm to 12.1 mm. The lengths of 10-10.4 mm (26%) were dominated. Very close to these were 9-9.4 mm (24%), followed by 8.5-8.9 mm (15%) and 8-8.4 mm (12%) (figure 12). Grains of smaller lengths of 7.5-7.9 mm constituted 3%, and those with 12-12.4 mm, 3%.

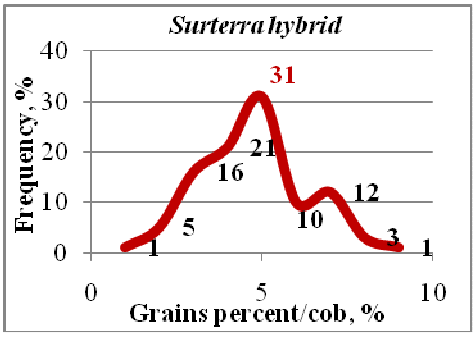

Figure 11. Frequencies of grains percent/cob, %:
<74, 74.1-76, 76.1-78, 78.1-80, 80.1-82,
82.1-84, 84.1-86, 86.1-88, >88.1

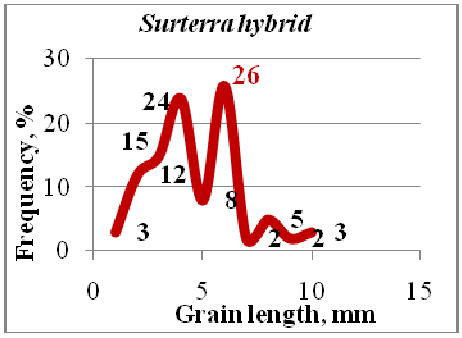

Figure 12. Frequencies of grain legth, mm:
7.5-7.9, 8-8.4, 8.5-8.9, 9-9.4, 9.5-9.9, 10-10.4,
10.5-10.9, 11-11.4, 11.5-11.9, 12-12.4

The width of the grain was within the large limits, ranging from 7.5 mm to 10.1 mm. The modal value was 8.7-8.9 mm (22%), followed closely by 9-9.2 mm (20%) and 8.1-8.3 mm (18%). And with regard to this character, there is a great variability, with large oscillations between categories (class limits) (figure 13). The third dimension of the grain, the thickness had values between 3.7 mm and 6.1 mm. The thickness of 4.9-5.1 mm (26%) and 4-4.2 mm (25%) dominated. Between these two frequencies, the grain thickness was between 4.6-4.8 mm (14%) and 4.3-4.5 mm (13%). Grains with the smallest thicknesses were 10%, while over 5.4 mm (three limits) were 4% (figure 14).

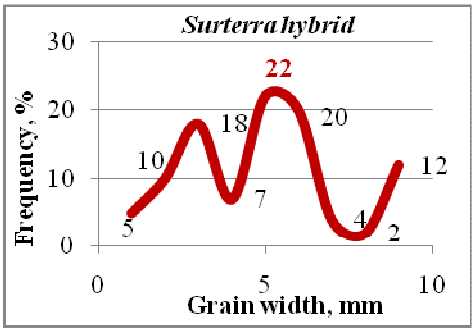

Figure 13. Frequencies of grain width, mm:
7.5-7.7, 7.8-8, 8.1-8.3, 8.4-8.6, 8.7-8.9,
9-9.2, 9.3-9.5, 9.6-9.8, 9.9-10.1

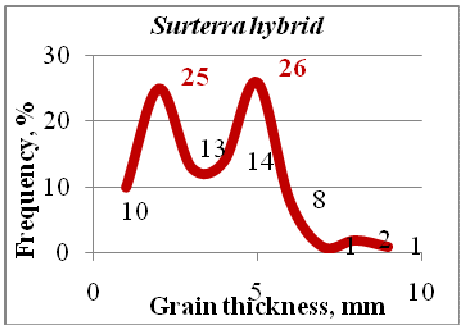

Figure 14. Frequencies of grain thickness, mm:
3.7-3.9, 4.0-4.2, 4.3-4.5, 4.6-4.8, 4.9-5.1,
5.2-5.4, 5.5-5.7, 5.8-6.0, 6.1-6.3

Correlations between the main characters. If we analyze the whole set of correlations between all the determined characters, positive and negative situations are found (Eberhart&Russel, 1966). Very obvious positive correlations have been observed between the characteristics of the cob: length, thickness, weight, total number of grains, total grain weight, one thousand grains weight and grain size (length and width). Positive insignificant correlations were observed between the grain thickness and the other characters of the cob. Negative correlations were observed between the grain percent/cob and all the other characters studied. The cause may be the condition of this hybrid and climatic factor, both of which determine the maize grain yield. The negatively correlations were

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between TGW and the number of rows, the number of grains/row with number of rows/cob, the grain width with grain number rows and grain number/row, grain thickness corelated negatively with the length of the grain (table 1).

Table 1. Corelations between different characters of maize cobs, Surterra hybrid, FAO 250

Character	Cob length, cm	Cob thick, cm	Cob weight, g	No. grains/ cob	No. rows/ cob	Grain weight/ cob, g	TGW, g	% grains/ cob	No. grains/ row	Grain length, mm	Grain width, mm	Grain thick, mm
Cob length, cm	1	**.709**	**.859**	**.787**	.026	**.872**	**.635**	**-.399**	**.809**	**.378**	**.361**	.142
Cob thick, cm		1	**.859**	**.729**	**.280**	**.865**	**.693**	**-.444**	**.570**	**.433**	**.209**	.162
Cob weight, g			1	**.798**	.141	**.992**	**.802**	**-.595**	**.734**	**.480**	**.379**	.187
No.grains/cob				1	**.376**	**.830**	**317**	**-.244**	**.805**	**.287**	.049	.163
No. rows/cob					1	.148	-.167	-.014	**-.235**	.073	**-.429**	.180
Grain weight/cob, g						1	**.785**	**-.495**	**.764**	**.483**	**.355**	.166
TGW, g							1	**-.562**	**.422**	**.459**	**.569**	.111
% grains/cob								1	**-.225**	-.188	**-.376**	**-.277**
No. grains/row									1	**.260**	**-.320**	.055
Grain length, mm										1	.162	-.172
Grain width, mm											1	**.228**
Grain thickness, mm												1
LSD 5 % = 0.19 LSD 1 % = 0.25 LSD 0.1 % = 0.32												

Statistical analysis of maize cobs morphological characters. The results obtained in the morphological analysis of some maize characters showed specific aspects (Eberhart & Russel, 1966). Thus, the length of the cob measured 16.6 cm. Variability has shown average coefficients (12%). The thickness of the cob measured 4.18 cm with a variation of 5.95% and its weight was 158.8 g (26.7% variation). The average number of grains per cob was 450.7 (15.9% variability), and the grain weight on the cob was 127 g (24.62% variability). The absolute mass of the grains was 279.7 g with a wilky variation (15.15%) (table 2).

The medium cob had 14 rows with grains (9.92% variability), and every row had 31.54 grains (17.26% variability). The grains percent/cob was 80.51% (30.32% maxim variation), and the dimensions of maize grains were 9.96 mm like length, 8.77 mm width, and 4.61 mm thickness. The grain dimensions have had smaller variability coefficients (table 3).

Table 2. Statistical indices of maize cobs, Surterra hybrid

Indices	Cob length, m	Cob thick, cm	Cob weight, g	No. grains/ cob	TGW, g	Grains weight/ cob, g
Media, ā	**16.60**	**4.18**	**158.8**	**450.7**	**279.7**	**127.0**
Variance, S^2	3.983	0.062	1798	5132	1796	978.0
Std, error S	1.996	0.249	42.40	71.64	42.38	31.27
Var, coef. %	**12.02**	**5.95**	**26.70**	**15.90**	**15.15**	**24.62**

Table 3.Statistical indices of maize grains, Surterra hybrid

Indices	No rows/ cob	No. grains/ row	% grains/ cob	Grain length, mm	Grain width, mm	Grain thick , mm
Media, ā	**14.34**	**31.54**	**80.51**	**9.96**	**8.77**	**4.61**
Variance, S^2	2.025	29.62	596.0	0.924	0.427	0.195
Std, error S	1.423	5.443	24.41	0.961	0.654	0.442
Var. coef., %	**9.92**	**17.26**	**30.32**	**9.65**	**7.45**	**9.59**

4. CONCLUSIONS

Morphological characters of maize cobs were specific to the early hybrid analyzed. Thus, the average length of the cob was 17 cm, the width in the middle portion was 4.2 cm. The cob weighed 159 g, formed 451 grains, on the 14 rows. The grains weighed 127 grams and had a thousand grains

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mass of 280 g. Grain percent/cob was 80.5%, and 32 grains were formed per row. Maize grain was 10 mm long, 8.8 mm wide and 4.6 mm thick.

Between all the studied characters were established simple correlations, with some differentiations. Between the characters of the cob, the correlations were generally positive and significant. Negative correlations were observed between the grain percentages/cob with all other characters. These aspects demonstrates that the cultivated Surterra hybrid has important productive posiibilities in this area of crop. The statistical indicators studied have demonstrated a maize hybrid that forms medium-sized cobs, with a lot of grains, and medium to high TGW. The grains from this *Zea maysindurata* form of *Surterra* hybrid were with length and width near similar dimensions.

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